Flare in Interference Based Hyperspectral Cameras

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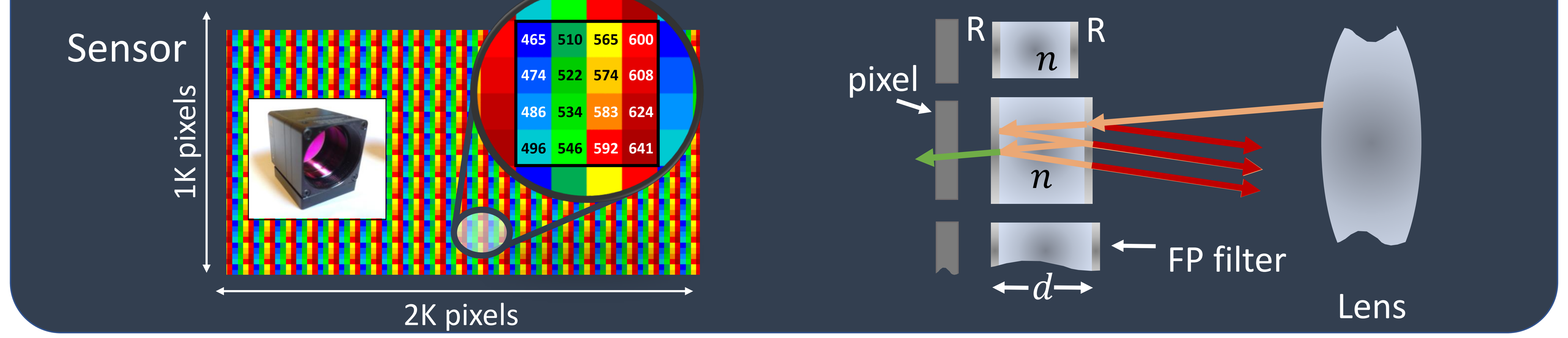
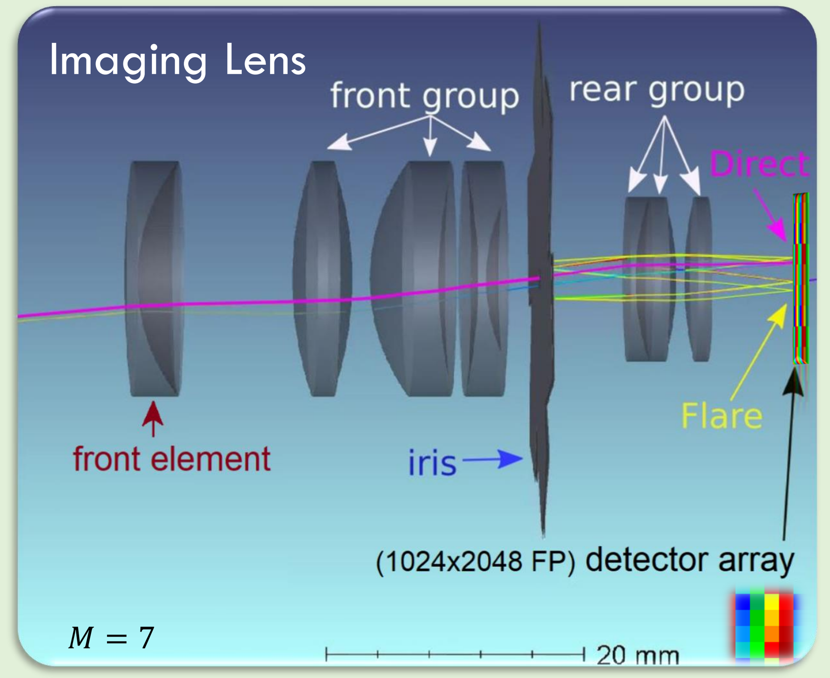
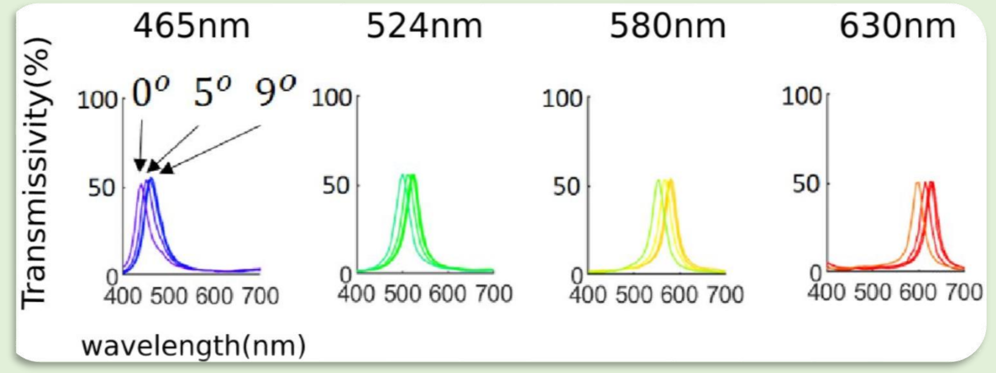
Summary

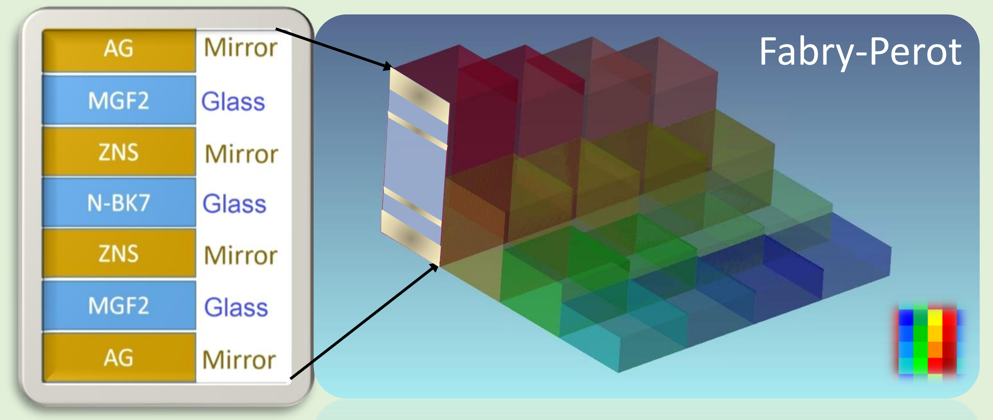
- Snapshot hyperspectral imagers use narrow band-pass interreference filters.
- While traditional broad-band filters absorb unwanted light, these narrow band-pass interference filters reflect non-transmitted light.
- We point out a flare effect of significant magnitude and implication to snapshot hyperspectral imagers.
- We present a theoretical image formation model for this effect and quantify it through simulations and experiments.
- We test deflaring of signals affected by such flare



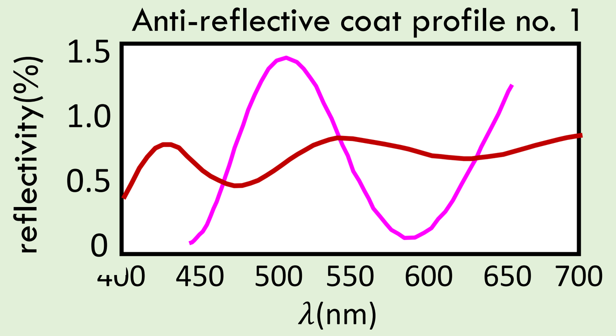
Simulation



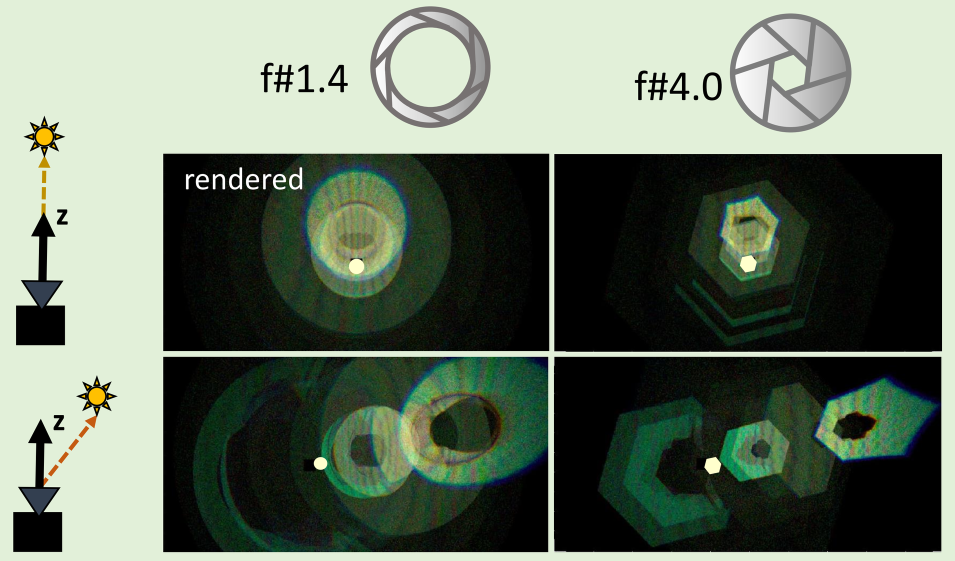




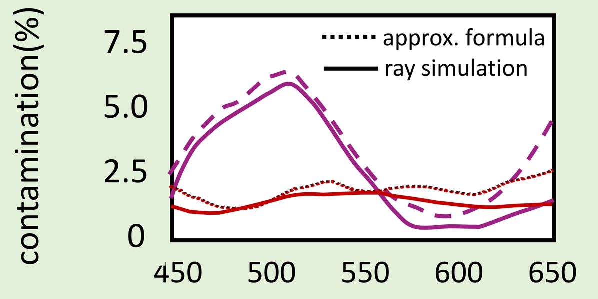
Array of FP form a single hyperspectral pixel. Multilayer design cancels out unwanted higher order resonance peaks in transmission



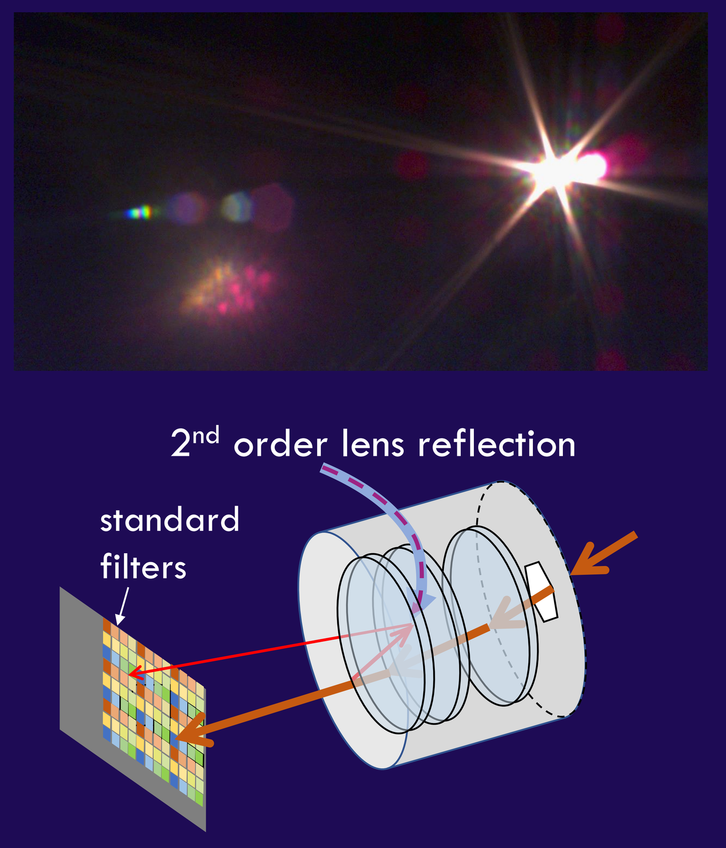
Rendered flare



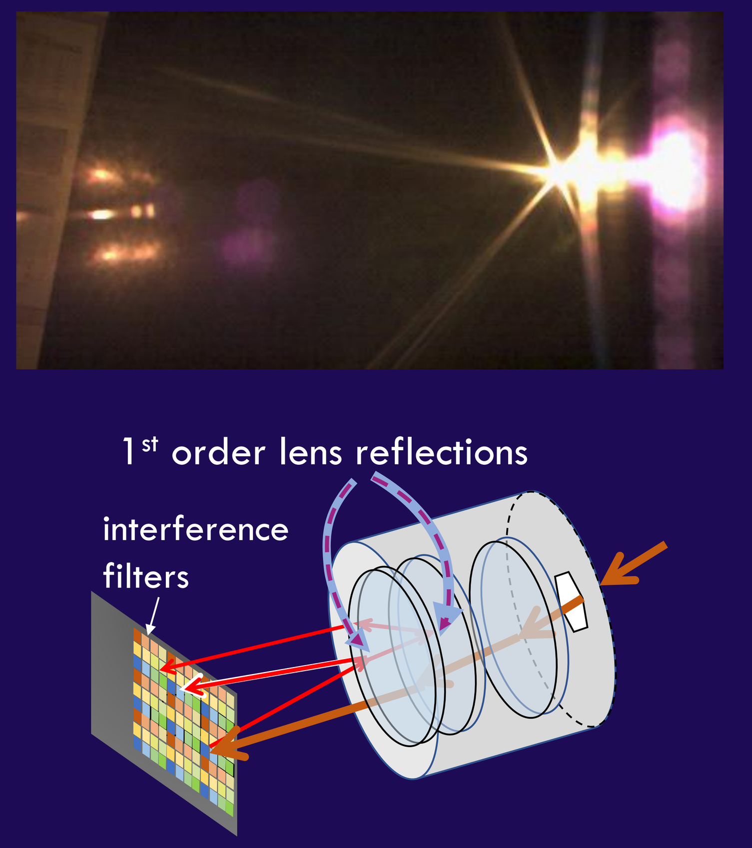
$$\text{Contamination}(\lambda) = E_{FP}(\lambda)/E_{source}(\lambda)$$



Flare Formation

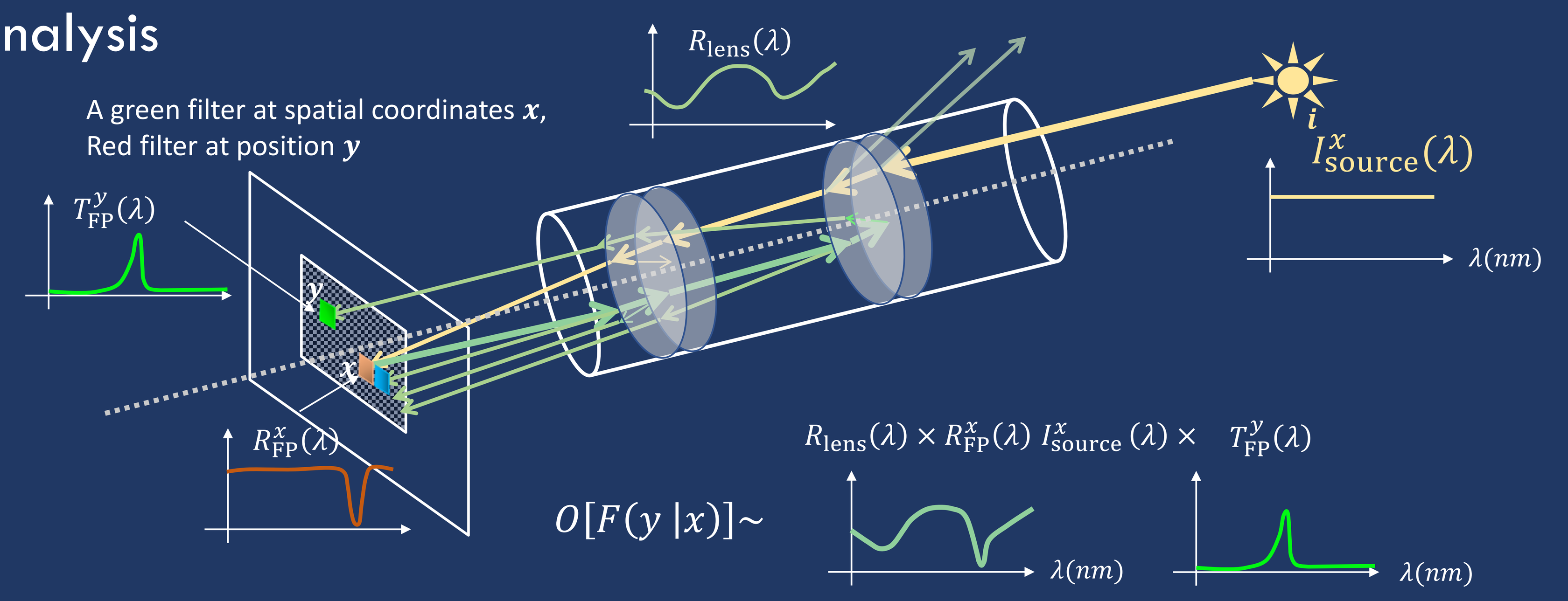


In regular cameras flare stems from secondary reflections



But flare in Interference based filters is formed by a 1st order (primary) lens reflection and thus much stronger

Photometric analysis



- M-Lenses cause $2M$ 1st order lens-reflections
- Flare recorded at y due to reflection at x is in the order : $O[F^{single}_{FP}(y)] \sim 2M \int_\lambda T^y_{FP}(\lambda) R_{lens}(\lambda) \sum_x I^x_{source}(\lambda) R^x_{FP}(\lambda) d\lambda$
- Total radiance : $E_{FP}(\lambda_b) = \sum_{y\in b} F^{single}_{FP}(y)$, $E_{source}(\lambda_b) = \sum_{x\in b} \int_\lambda I^x_{source}(\lambda) T^x_{FP}(\lambda)$
- Contamination due to 1st order lens-reflections:

$$C(\lambda_b) = E_{FP}(\lambda_b)/E_{source}(\lambda_b)$$

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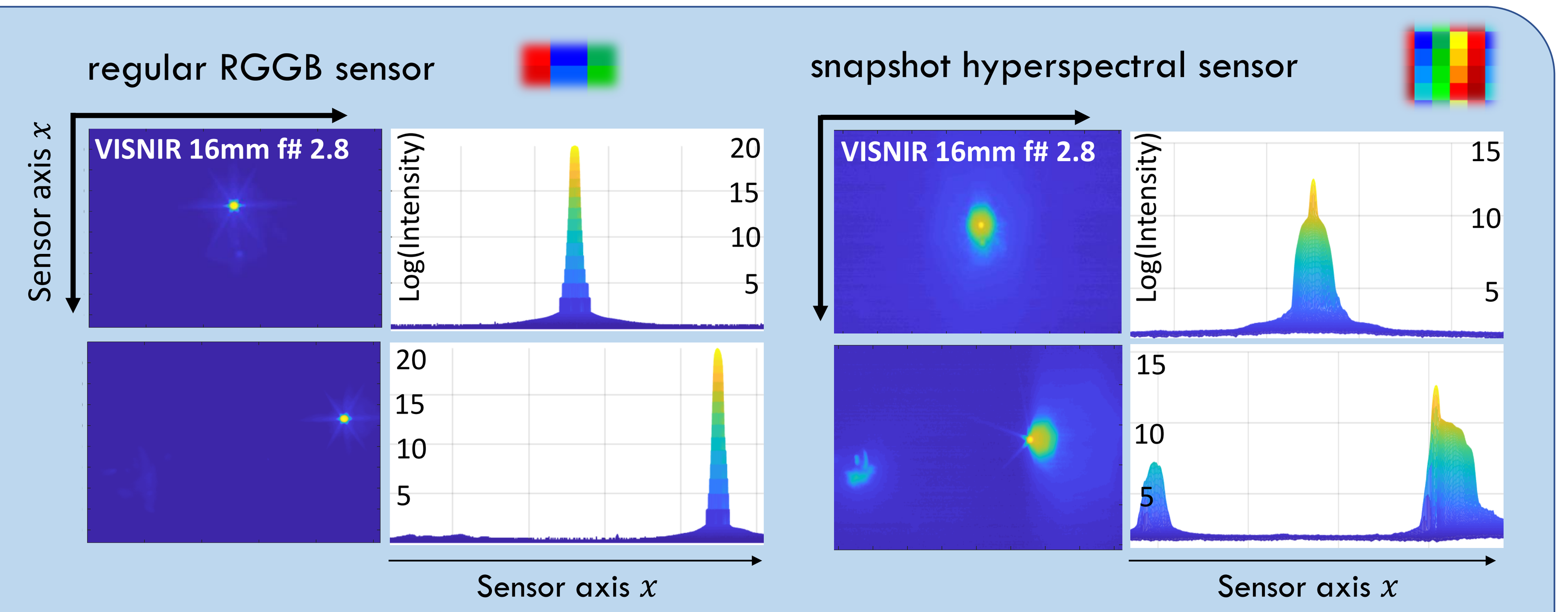
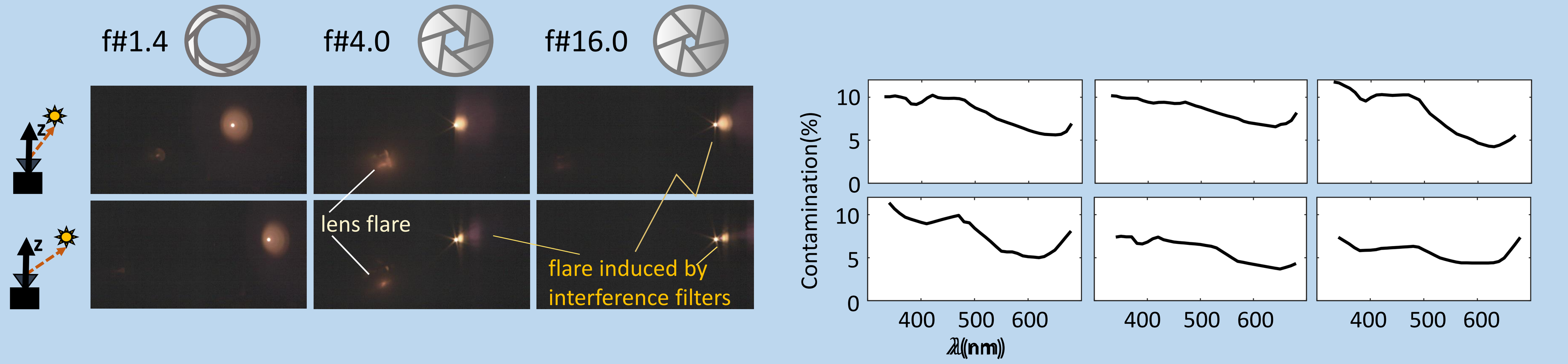
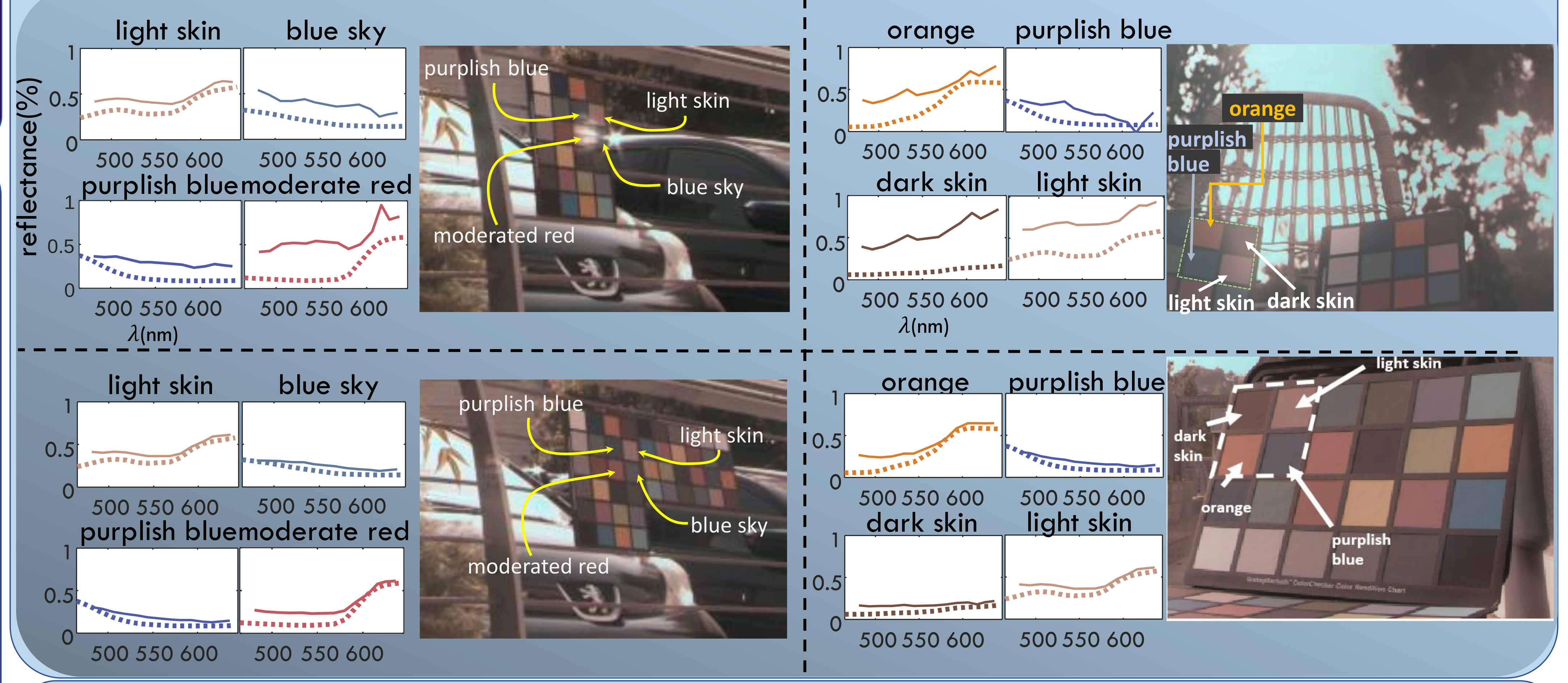
Experiments

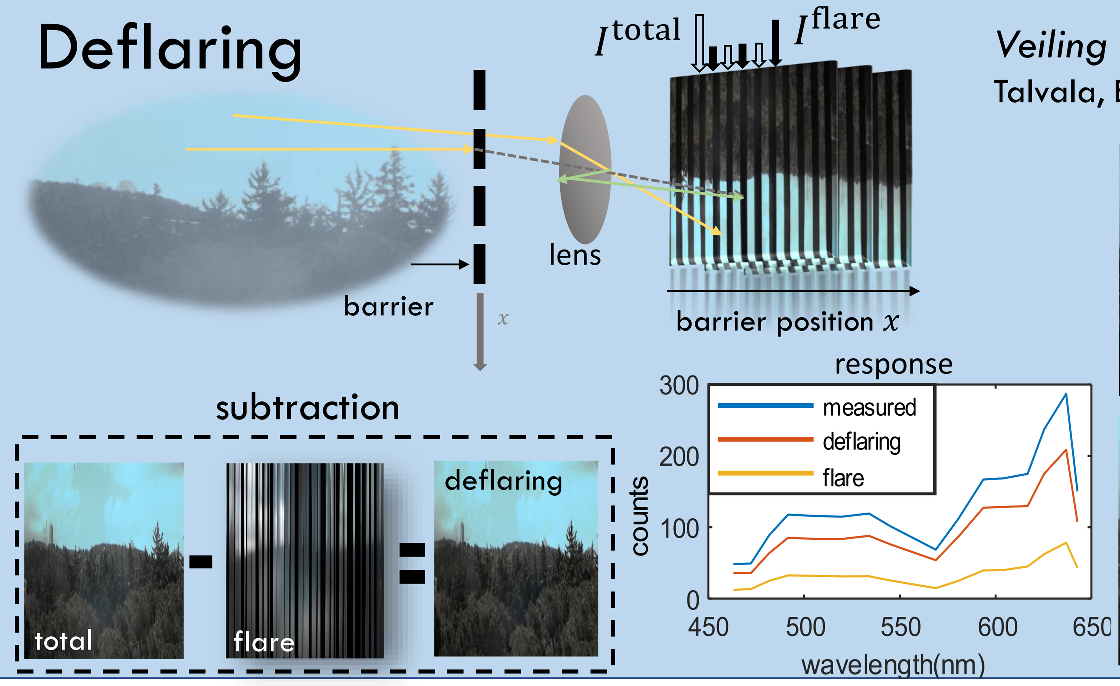
Flare in both cameras is compared using an identical setup







Deflaring



Veiling glare in high dynamic range imaging, Talvala, E.V., Adams, A., Horowitz, M. and Levoy, M., ACM TOG, 2007